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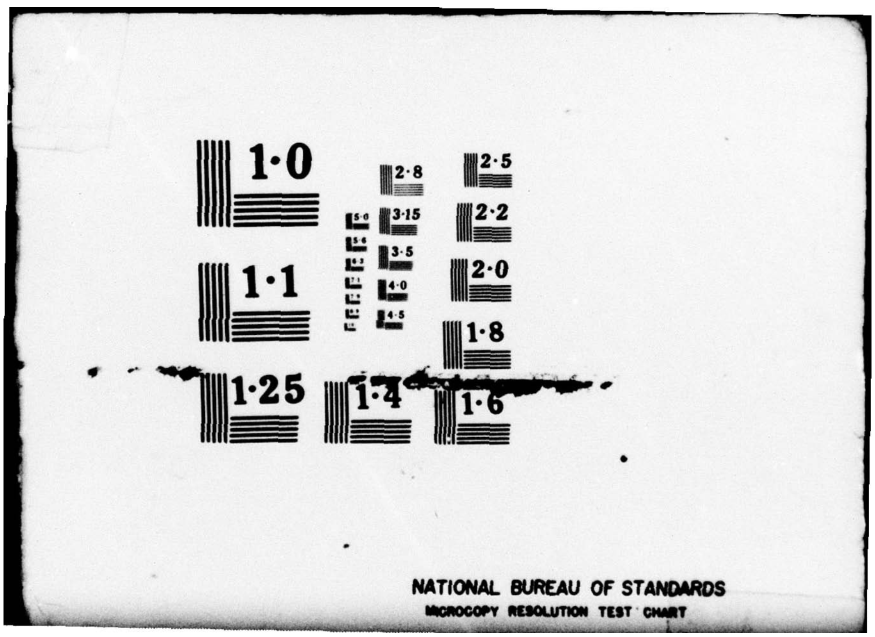
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INTRODUCTION

This report describes progress under NASC Contract N00019-78-C-0131 during the second quarterly period. There are four areas of work under this contract. The first is a continuation of experimental work, started under the previous contract, on the use of adaptive arrays with AM and FM signals. The second and third areas involve research on the problem of frequency acquisition in adaptive arrays and the use of analog phase modulation for desired signal tagging. The last area involves the preparation of a monograph on adaptive arrays.

PROGRESS

During this quarter, work has been done in three areas as described below:

(1) Studies on Dynamic Range

Studies on a modified form of the LMS feedback loop have been continued. This loop has the property that it eliminates the problem of eigenvalue spread and time constant variation with signal power. (A block diagram of the loop was given in a previous quarterly report (1).) Recent research has been concerned with the averaging operation required in the new loop. The objective is to determine the most convenient form of averaging for implementation in an analog loop.

During this quarter, a talk on the modified feedback loop was given at the IEEE Communication Theory Workshop*, and a paper describing this concept has been submitted to Proceedings of the IEEE. In addition, a contract report on this subject is in preparation.

(2) Frequency Acquisition in Adaptive Arrays

Methods of acquiring desired signal carrier frequency in adaptive arrays are being investigated. The approach being considered is to switch the array to a power inversion mode for initial acquisition, and to dither the feedback loop gain while the array is in the power inversion mode.

The problem with power inversion is the difficulty of knowing where to set the loop gain. With no interference, the loop gain should be low to prevent desired signal nulling. With strong interference, the loop gain should be large, to obtain a high signal-to-interference-plus-noise ratio (SINR) at the array output. Figure 1 shows a typical set of curves of output SINR for a two- element power inversion array as a function

*Eighth Annual Communication Theory Workshop, Sandpiper Bay, Port St. Lucie, Florida, April 16-19, 1978.

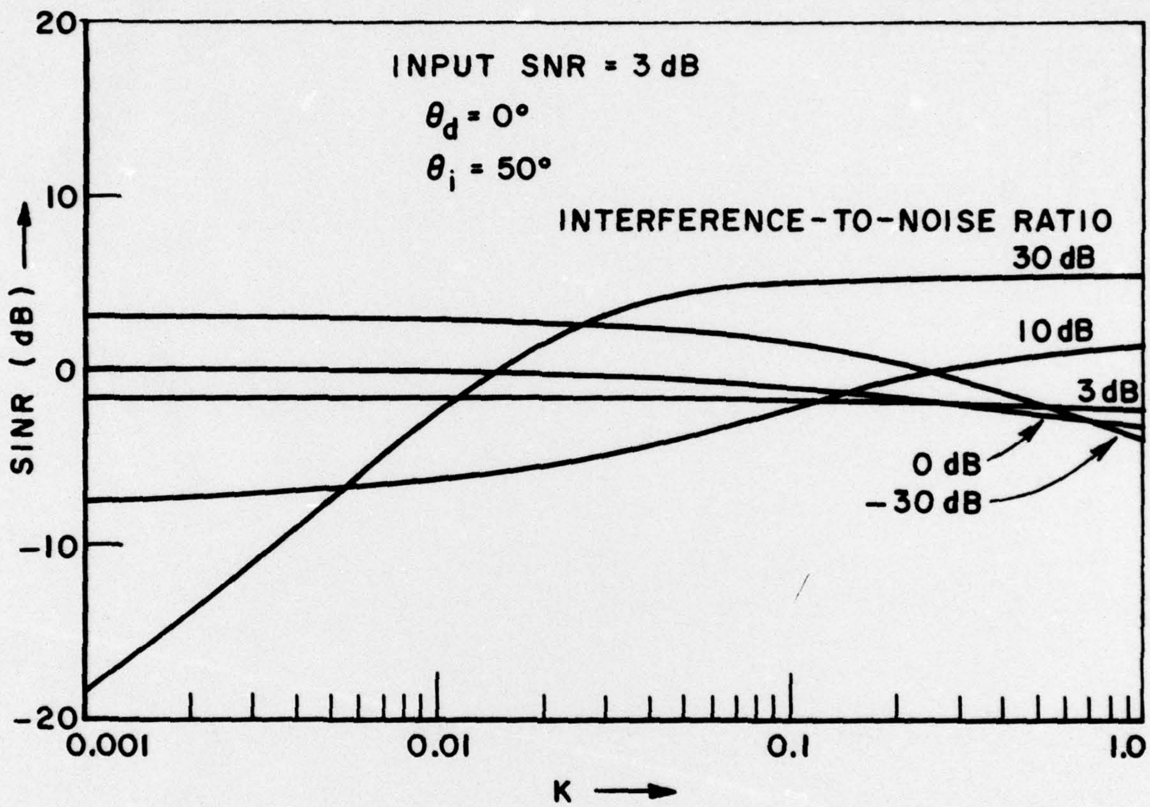

Figure 1. Output SINR vs loop gain.

of the loop gain K*. These curves are for narrowband desired and interference signals at broadside and 50° off broadside, respectively, and half wavelength element spacing. Also, the input desired signal is 3 dB above thermal noise. It may be seen that the output SINR is never less than -1.7 dB if K can be properly chosen for any given input interference power.

The approach being considered in this study is to vary the loop gain K in a periodic fashion, such as shown in Figure2. Over a typical period from 0 to T, the values of K span the range needed to insure that somewhere in this range the output SINR from the array will be adequate for locking. It is assumed that there will be pseudonoise coding (or some other form of tagging) on the desired signal, so that both frequency and code timing will be acquired during the time when the SINR is acceptable. The speed with which the feedback loop gain can be slewed is determined by the minimum time required to lock the desired signal frequency and code. This minimum lockup time in turn depends on the available SINR. This tradeoff is being studied.

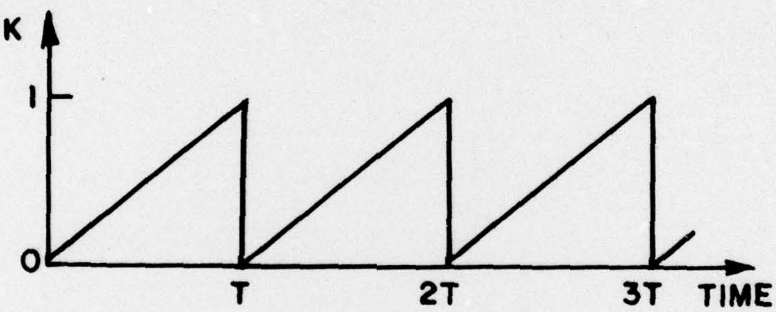

Figure 2. Loop Gain vs Time.

(3) FM System Design

Design work on a phase-switched FM reference signal generation circuit is being continued. During this quarter, the primary effort has involved the lockup characteristics of the interacting phase-lock and delay-lock loops. As part of this study we are considering the design of a reference loop to operate with the new fixed time constant array feedback loop. It appears that the use of this modified LMS loop will considerably improve the performance of a coded FM system.

REFERENCES

1. R. T. Compton, Jr., "Communication Applications of Adaptive Arrays," Quarterly Report 710929-1, April 1978, The Ohio State University ElectroScience Laboratory, Department of Electrical Engineering; prepared under Contract N00019-78-C-0131 for Naval Air Systems Command.

*K is normalized loop gain: $K = 2k\sigma^2$, where k = the LMS loop gain and σ^2 = thermal noise power.